WHAT IS CLAIMED IS:

1. A system, comprising:

a probe module, having a probe responsive to a probe excitation field to produce a probe polarization, a sample holder holding a sample which has a sample polarization, and a mechanical oscillator engaged to one of said probe and said sample holder to move in response to an interaction between said probe polarization and said sample polarization;

a detection module to measure a response of said mechanical oscillator to produce a signal indicative of a property of the sample.

2. The system as in claim 1, wherein the detection module includes a detecting device that measures a displacement of said mechanical oscillator.

3. The system as in claim 2, wherein said detecting device includes a light source to produce a detection optical wave to illuminate at least a portion of said mechanical oscillator, a photodetector to receive scattered detection wave.

4. The system as in claim 1, wherein said probe module produces a probe excitation radiation wave at a probe frequency to effectuate said probe excitation field and a

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sample excitation wave at a sample frequency different from said probe frequency, wherein said sample polarization is caused by said sample excitation wave.

5. The system as in claim 4, wherein said probe frequency and said sample frequency are different from each other by an amount within a frequency response range of said mechanical oscillator.

6. The system as in claim 5, wherein said amount is equal to or near a fundamental resonant frequency of said mechanical oscillator.

7. The system as in claim 5, wherein said amount is equal to or near a harmonic frequency of said mechanical oscillator.

8. The system as in claim 5, wherein said probe module includes a radiation source and both of said probe excitation wave and said sample excitation wave are originated from a common wave generated from said radiation source.

9. The system as in claim 8, wherein said radiation source includes a laser to produce one of said sample and said probe excitation waves, and wherein said probe module includes an acousto-optic modulator which modulates said laser to

produce another of said sample and said probe excitation

waves.

10. The system as in claim 8, wherein the output of said radiation source is modulated.

11. The system as in claim 10, wherein the modulation frequency is about one half of the frequency difference between said sample and probe frequencies.

12. The system as in claim 8, wherein the output amplitude is modulated.

13. The system as in claim 8, wherein the output polarization is modulated.

14. The system as in claim 1, further comprising a feedback loop to maintain said mechanical oscillator at a resonance condition.

15. The system as in claim 1, wherein said probe module includes at least another probe.

16. The system as in claim 1, further comprising a spacing monitor mechanism to monitor a spacing between said probe and said sample.

17. The system as in claim 1, wherein said probe is spaced from the sample by less than one wavelength of radiation.

18. The system as in claim 1, wherein said mechanical oscillator has a dimension less than one wavelength of radiation.

19. The system as in claim 1, wherein said mechanical oscillator has a dimension greater than one wavelength of radiation and wherein the inverse of a wavevector difference of incident radiation waves is less than the inverse of a dimension of said mechanical oscillator.

20. A system, comprising:

a radiation source to produce at least a probe excitation wave at a probe frequency;

a probe having an array of mechanical oscillators to receive said probe excitation wave, each mechanical oscillator responsive to said probe excitation wave to produce a probe polarization;

a sample holder to hold a sample with a sample polarization in a proximity of said probe to expose the sample to fields produced by said probe polarizations so as to cause

motion of said mechanical oscillators from interaction between

the probe polarization and the sample polarization; and

a detector module to measure movements of said

mechanical oscillators.

21. The system as in claim 20, further comprising a

detection radiation source to produce a detection radiation

wave to illuminate said mechanical oscillators, wherein said

detector module collects and measures scattered detection

radiation wave to determine movements of said mechanical

oscillators.

22. The system as in claim 20, further comprising a

mechanism to turn on and off said mechanical oscillators

individually.

23. The system as in claim 22, wherein said mechanical

oscillators are turned on and off individually according to a

Hademard matrix.

24. The system as in claim 20, wherein said sample holder

is movable to shift said sample relative to said probe.

25. The system as in claim 20, said mechanical

oscillators are modulated to write information in the sample.

26. The system as in claim 20, said mechanical oscillators are operated to retrieve information recorded in the sample.

27. The system as in claim 20, wherein said radiation produces at least another excitation wave at a frequency different said probe frequency but coherent with said probe excitation wave to produce an interference field over said mechanical oscillators, said mechanical oscillators responsive to said interference field to produce polarizations representative of said interference field.

28. A method, comprising:

producing a probe polarization by exposing a probe formed of a polarizable material to a probe excitation field;

placing a sample with a sample polarization in a field of said probe polarization to effectuate an interaction between the probe and the sample;

engaging a mechanical oscillator to at least one of said probe and said sample, wherein said oscillator moves in response to said interaction;

detecting motion of said oscillator to measure a property of said sample.

29. The method as in claim 28, further comprising

exposing said sample to a sample excitation field to produce

said sample polarization.

30. The method as in claim 29, further comprising:

using a probe radiation wave at a probe frequency to

effectuate said probe excitation field; and

using a sample radiation wave at a sample frequency

different from said probe frequency to effectuate said sample

excitation field, wherein said sample radiation wave and said

probe radiation wave are coherent to each other.

31. The method as in claim 30, wherein the difference

between said probe frequency and said sample frequency is

equal to or near a resonance frequency of said mechanical

oscillator.

32. The method as in claim 30, wherein the difference

between said probe frequency and said sample frequency is

equal to or near a harmonic frequency of a resonance frequency

of said mechanical oscillator.

33. The method as in claim 32, wherein said harmonic

frequency is a second harmonic of the resonance frequency.

34. The method as in claim 29, further comprising using
another electromagnetic polarization, different from said
sample polarization and said probe polarization, to affect the
motion of said mechanical oscillator.

35. The method as in claim 28, further comprising
illuminating said mechanical oscillator with a detection
radiation wave at a detection frequency and detecting a
scattered detection radiation wave whose frequency is shifted
from said detection frequency due to the sample and probe
interaction.

36. The method as in claim 28, further comprising
scanning said probe and said sample relative to each other to
obtain an image of said sample.

37. The method as in claim 30, further comprising
modulating a polarization or said probe frequency of said
probe excitation wave.

38. The method as in claim 30, wherein said probe
includes a tip which is less than one wavelength of said probe
excitation wave to allow evanescent coupling.

39. The method as in claim 28, further comprising:

detecting motion of said oscillator to measure a

property of said sample at a first time;

detecting motion of said oscillator to measure the

property at a second time; and

correlating measurements from said first and said

second times to determine the property.

40. The method as in claim 28, wherein said mechanical

oscillator is engaged to said probe, and further comprising:

engaging a second probe to a second mechanical

oscillator to measure the property of said sample; and

correlating measurements from said probe and said

second probe to determine the property.

41. The method as in claim 40, wherein said measurements

from said probe and said second probe are performed at

different times.

42. The method as in claim 40, wherein said measurements

from said probe and said second probe are performed at the

same time.

43. The method as in claim 28, further comprising measure

the property of said sample a plurality of times when a

parameter associated with excitation of said probe or sample

is adjusted to have different values.

44. The method as in claim 28, wherein said interaction between said sample and said probe includes a dissipative interaction.

45. A method of nonlinear wave mixing, comprising:

using a probe radiation wave at a probe frequency to excite a probe to produce a probe polarization;

using a sample radiation wave at a sample frequency to excite a sample to produce a sample polarization;

positioning said sample close to said probe to allow interaction;

engaging an oscillator to at least one of said sample and said probe so that said oscillator moves in response to said interaction; and

using a detection radiation signal at a detection frequency to illuminate said oscillator to produce a wave mixing signal by light scattering at a scattered frequency which is a function of said sample frequency and said probe frequency.

46. The method as in claim 45, wherein the difference between said probe frequency and said sample frequency is equal to or near a fundamental resonance frequency of said oscillator.

47. The method as in claim 45, wherein the difference between said probe frequency and said sample frequency is equal to or near a harmonic frequency of a resonance frequency of said oscillator.

48. The method as in claim 45, further comprising using the same probe radiation wave to excite a second probe to interact with the sample, wherein the radiation from the second probe is coherent with the radiation from the probe.

49. The method as in claim 45, wherein said scattered frequency is equal to a frequency difference between said sample frequency and said probe frequency plus or minus said probe frequency.

50. A method, comprising:

using a probe excitation wave to illuminate an optically polarizable probe tip, the tip responsive to produce a probe polarization; and

scanning the probe tip in the proximity of a sample to interact with the sample with a sample polarization and to obtain measurements of different parts of the sample,

wherein incident light scattered from a combination of sample and tip is modulated in its polarization or frequency as it is scanned through electromagnetic resonances of the sample.